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HANDBOOK
OPERATION INSTRUCTIONS

REQUISITION

PULSE GENERATOR SET

AN/UPM-15

(STAMFORD ELECTRONICS)

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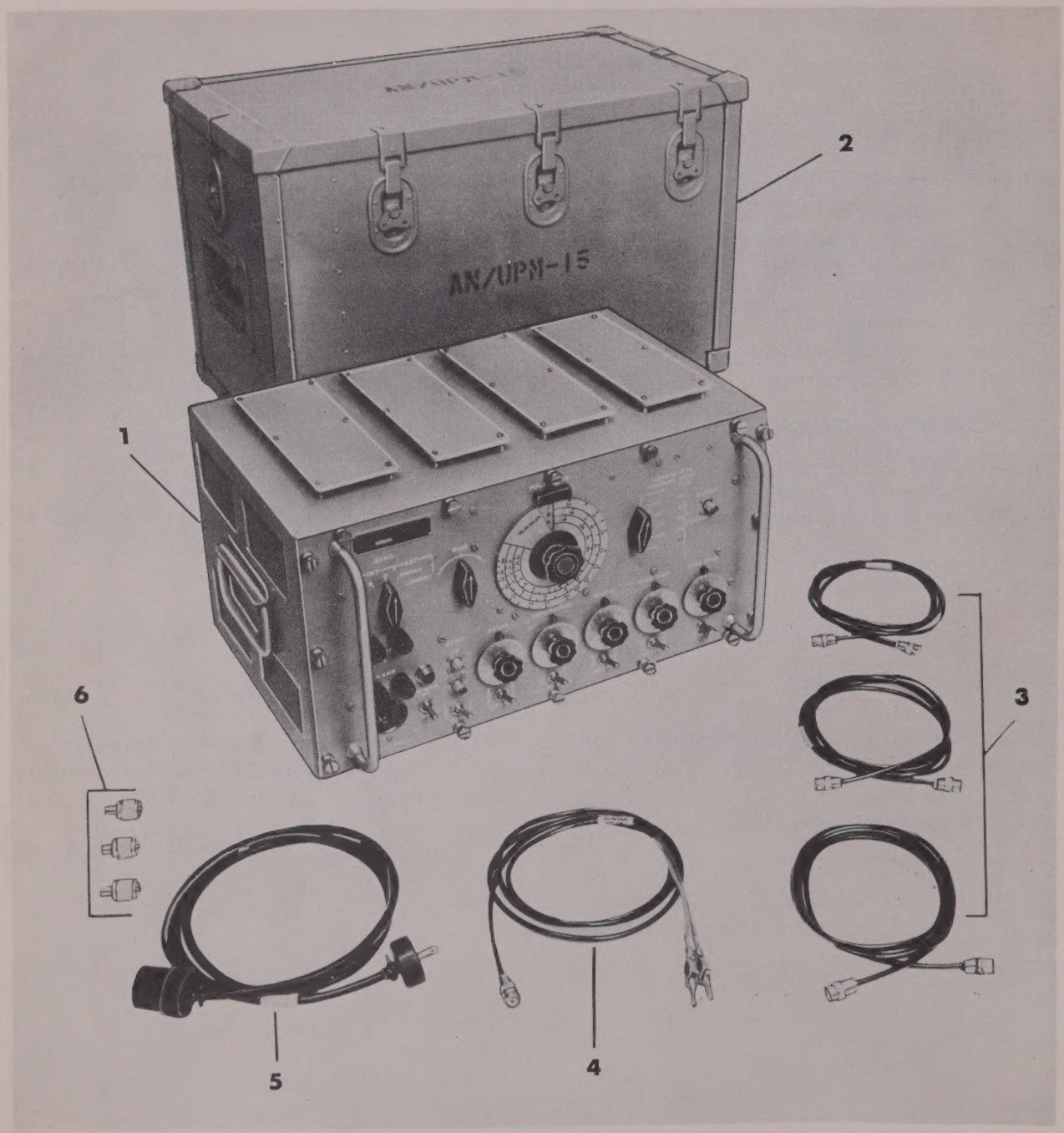


1. Pulse Generator TS-592/UPM-15 or Pulse Generator TS-592A/UPM-15
2. Transit Case CY-672/U
3. Cord CG-409A/U
4. Cord CG-521A/U
5. Cord CX-337/U
6. Adapter UG-273/U

Figure 1-1. Pulse Generator Set AN/UPM-15

SECTION I
GENERAL DESCRIPTION

1-1. GENERAL

1-2 This handbook provides information for the operation of Pulse Generator Set AN/UPM-15, manufactured by Stamford Electronics Co., Stamford, Conn.

1-3. PURPOSE OF EQUIPMENT.

1-4. Pulse Generator Set AN/UPM-15 (figure 1-1) is a general purpose video electronic generator. It is intended to be used in the calibration of radar equipment, in field and depot maintenance and in laboratory work. It produces output wave shapes that are essentially rectangular. By means of manual controls it is possible to produce a wide range of pulse amplitudes, widths, repetition rates and delays. It is possible to synchronize the equipment either with an internal oscillator, or with external sources producing wide varieties of wave forms, frequencies and amplitudes.

1-5. EQUIPMENT SUPPLIED.

1-6. The pulse generator set consists of the components shown in Table 1-1. No other equipment is required. Pulse Generators with serial numbers AF-1 thru 536 have the nameplate designation TS-592/UPM-15. Pulse generators with serial numbers AF-537 thru 1358 have the nameplate designation TS-592A/UPM-15. These latter pulse generators have additional internal trimmer controls. The overall circuit and method of operation is identical for all units.

Table 1-1. Equipment Supplied

Quantity	*Name of Component*	*Government Type Designation*
1	Pulse Generator	TS-592/UPM-15
1	Transit Case	CY-672/U
1	Cord (6 ft.)	CX-337/U
3	Cord (6 ft.)	CG-409A/U
1	Cord (6 ft.)	CG-521A/U
3	Adapter	UG-273/U

1-7 CAPABILITIES.

1-8. OUTPUTS. This pulse generator is capable of providing a 1.5 usec sync pulse and one or two output pulses. Output pulses are essentially rectangular in shape. The total time base available is 255 usec. Minimum separation is 2 usec. It is possible to turn off the second output pulse.

1-9. EXTERNAL SIGNALS. Externally supplied signals may have an amplitude of from 5 to 100 volts. External signal frequency may vary from 50 to 10,000 cps. However, if the signal is a sawtooth shape, the minimum acceptable frequency is 25 cps.

1-10. AMBIENT TEMPERATURE RANGE. The pulse generator is designed to operate within a temperature range of —40°C (—40°F) to +55°C (+131°F).

1-11. LIMITATIONS.

1-12. INTERNAL OSCILLATOR CALIBRATION. Calibration of the repetition rate ("PULSE RATE" dial) is accurate within ±5 percent at a temperature of ±21°C (70°F). Accuracy is +10 percent at the high and low ends of the temperature range stated in paragraph 1-10.

1-13. PULSE OUTPUTS. Accuracy of all controllable characteristics of pulse outputs is ±10 percent.

1-14. BIAS CONTROL. While externally applied signals may reach a maximum of 100 volts, controllable amplitude of a triggering pulse is limited to 40 V, peak voltage. This condition applies because the pulse generator bias control is confined to a range of —40 to +40 V.

1-15. POWER REQUIREMENTS. This pulse generator requires 115 volts ±10 percent, single phase, 50 to 1000 cps. It draws approximately 275 watts.

Note

Illustration of wave forms and specific numerical values stated, are based on wave forms produced in an oscilloscope having 0.03 usec rise time.

1-16. THEORY OF OPERATION

1-17. PULSES. The pulse generator supplies a sync pulse and a choice of one or two output pulses. In the rest of this discussion the sync pulse and the one or two output pulses are lumped together and called the pulse pattern. The pulse pattern is repeated at a

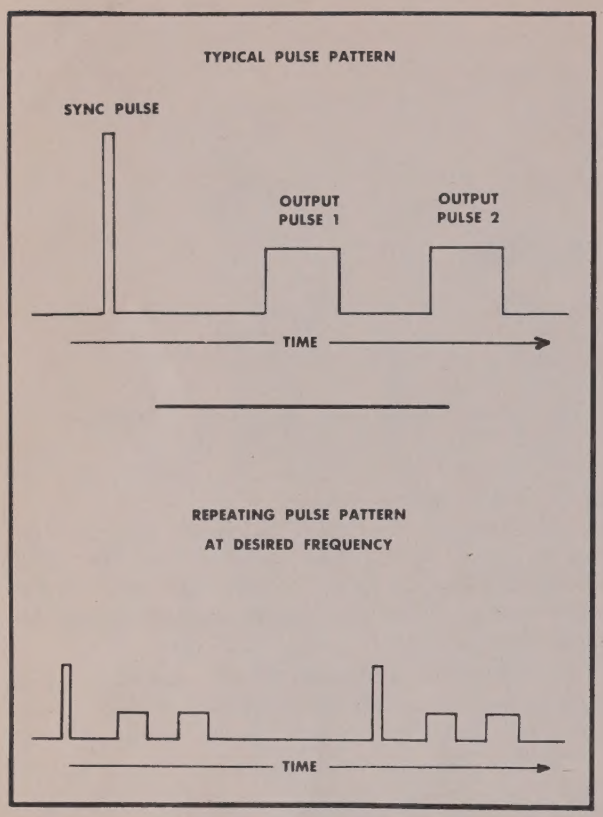


Figure 1-2. Function of Pulse Generator

frequency of from 50 to 10,000 cps depending on the setting of controls. A typical pulse pattern is shown at the top of figure 1-2. The repetition of the same pulse pattern is illustrated at the bottom of figure 1-2.

1-18. In the pulse pattern, this pulse generator provides two distinct types of pulse relationships. They are called Sync Lead Condition and Sync Lag Condition. Time measurements in the following explanations are made between leading edges of pulses. Leading edges are the left sides of the wave forms in figures 1-2 and 1-3.

1-19. SYNC LEAD CONDITION. (See figure 1-3). In this condition, the pulse pattern starts at zero time (T-o). Delay time (T-d) can be set to occur 2 to 225 usec after T-o. Separation time (T-s) can be set to occur 2 to 30 usec after T-d.

1-20. SYNC LAG CONDITION. (See figure 1-3.) The significant alterations from sync lead condition are:

a. Overall length of the pulse pattern is reduced to 225 usec.

b. T-s now is variable with reference to T-o rather than T-d.

1-21. The connection between T-o, T-d and T-s and the individual pulses is shown by figure 1-3.

1-22. PULSE CHARACTERISTICS.

1-23. SYNC PULSE. Characteristics of the sync pulse are constant. Polarity is positive. Amplitude is 50 volts. Width is 1.5 usec. Rise time is 0.10 usec. Decay time is 0.4 usec.

1-24. OUTPUT PULSES. Wave forms of the output pulses are identical because control adjustments affect both pulses when the second output pulse is used. Polarity may be either positive or negative. Width may be from 0.5 to 100 usec. Amplitude may range from 0.0 to 200 volts. Rise time ranges from 0.05 to

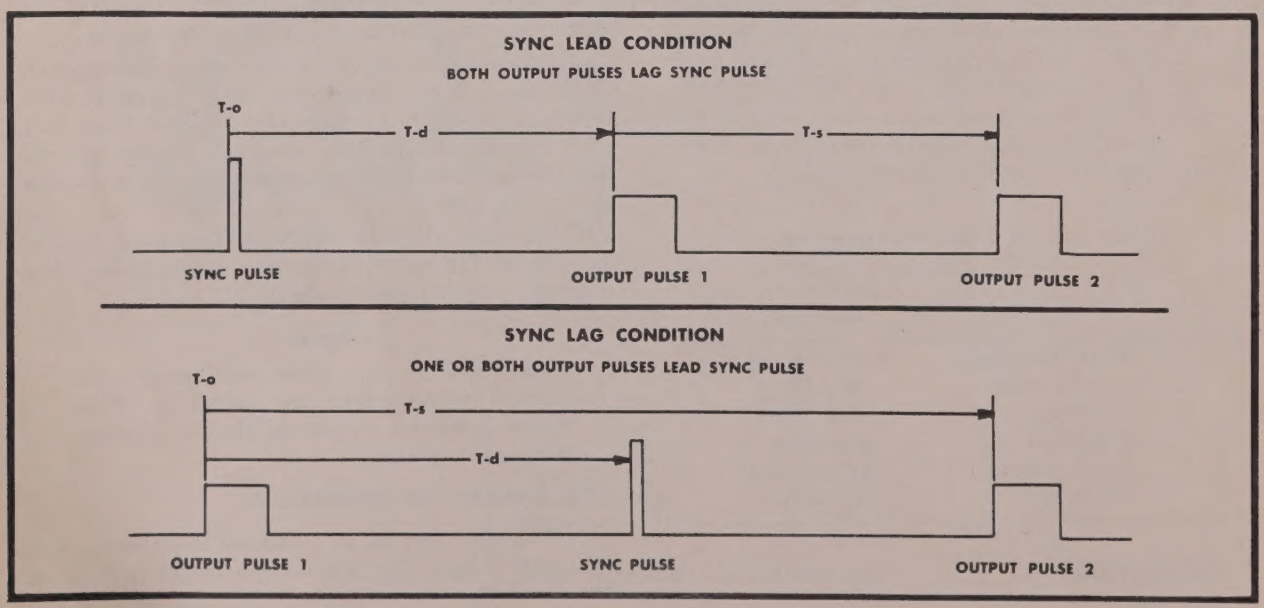


Figure 1-3. Pulse Relationships

0.25 usec. Decay time varies from 0.1 to 0.3 usec. Rise time is a function of the output loading. At the higher output voltages of from 2 volts to the maximum of 200 volts, better rise time can be gained by using shortest possible connecting leads. Follow instructions in the note at the end of paragraph 2-5.

1-25. RESPONSE TO EXTERNAL TRIGGERING. External triggering of from 50 to 10,000 cps can be applied to this pulse generator. When an external wave form is connected to the pulse generator, "BIAS" and "EXT SYNC" adjustments are available to make the pulse pattern occur at the desired point on the externally applied waveform. The "BIAS" adjustment allows the triggering potential to be varied continuously from 0.0 to −40V and from 0.0 to +40V. The "EXT SYNC" adjustments sense the slope of the external wave form. Triggering can thus be placed as desired on the wave form to secure pulses during a "GOING+" or "GOING−" slope of the wave form. (See figure 1-4).

1-26. INTERNAL TRIGGERING CHARACTERISTICS. When triggered by its internal oscillator, the pulse generator has a fixed bias. Frequency range is variable 50 to 10,000 cps.

1-27. SERVICES SUPPLIED BY PULSE GENERATOR. The following is a general summary of the services provided by the pulse generator.

a. It provides a pulse pattern consisting of a sync pulse and one or two output pulses.

b. Sequence of sync and output pulses may be selected.

c. Wave form of the output pulses may be controlled to provide a variety of triggers and gates for calibrating other equipment.

d. The pulse pattern selected may be repeated at from 50 to 10,000 cps, depending on the pulse pattern's width.

e. When an external oscillator is used to repeat the pulse pattern, the point of triggering the pulse generator may be biased from −40 to +40V. Also, the point of triggering may be set at any point "GOING+" or "GOING−" along the external wave form, within the 40 volt limit.

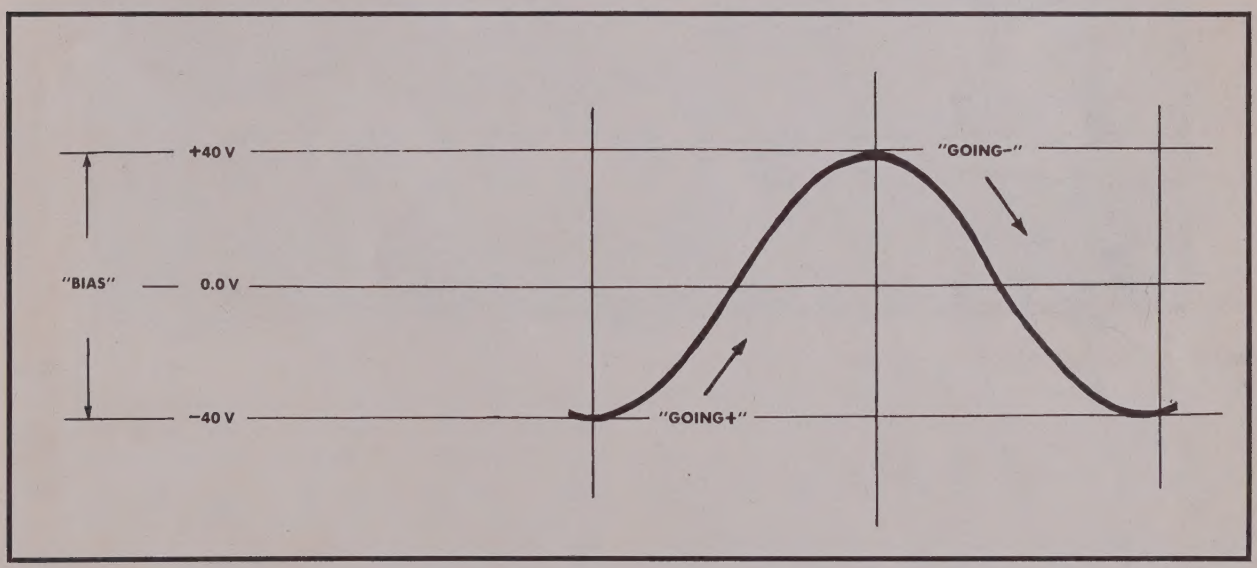
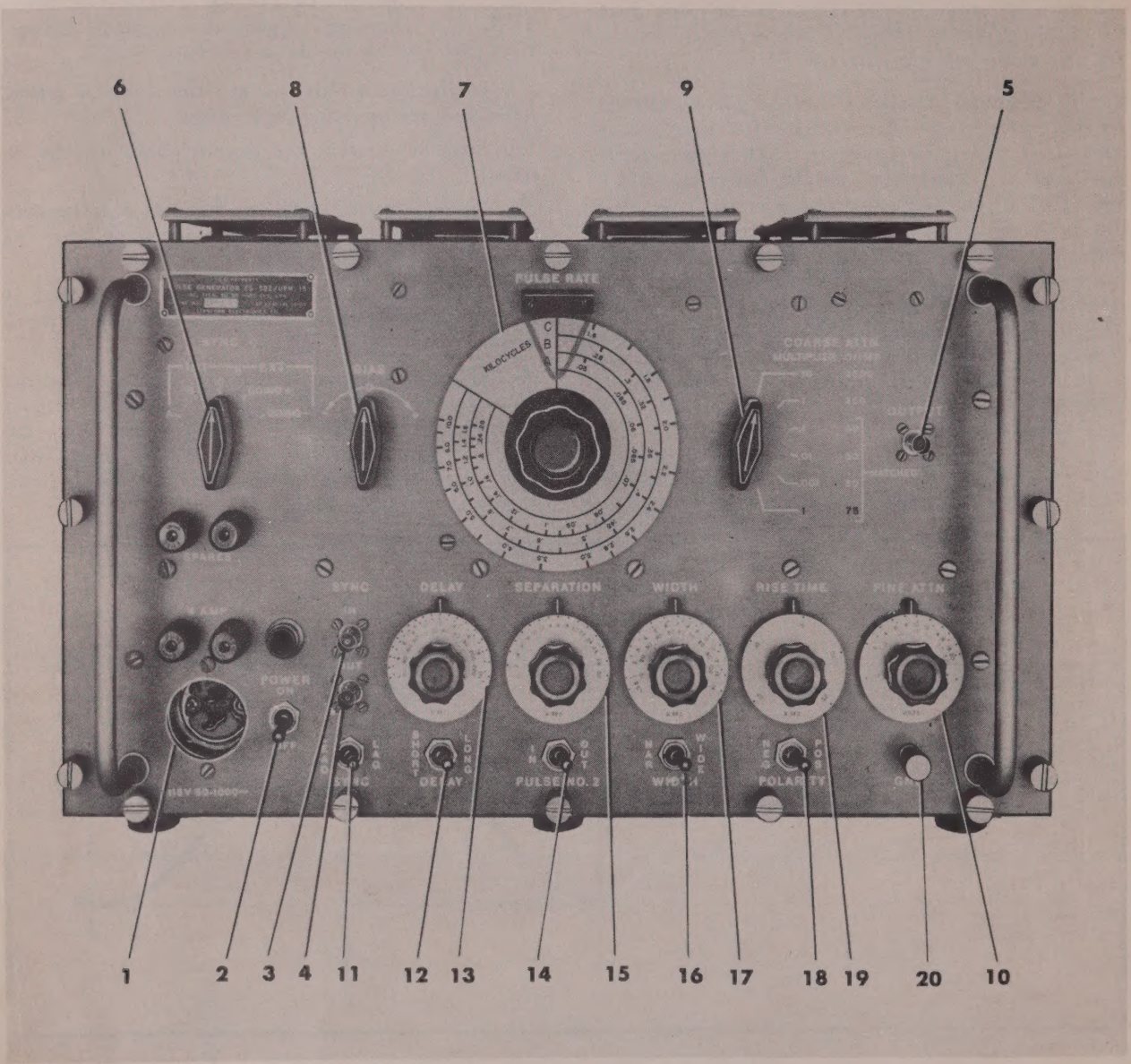


Figure 1-4. External Triggering Range



1. "POWER" connector
2. "POWER" switch
3. "SYNC IN" connector
4. "SYNC OUT" connector
5. "OUTPUT" connector
6. "SYNC" selector knob
7. "PULSE RATE" dial
8. "BIAS" knob
9. "COARSE ATTN" knob
10. "FINE ATTN" dial
11. "SYNC" switch
12. "DELAY" switch
13. "DELAY" dial
14. "PULSE NO. 2" switch
15. "SEPARATION" dial
16. "WIDTH" switch
17. "WIDTH" dial
18. "POLARITY" switch
19. "RISE TIME" dial
20. "GND" connector

Figure 2-1. Pulse Generator Operating Controls

SECTION II

OPERATING PROCEDURES

2-1. DESCRIPTION OF CONTROLS.

2-2. The continuously adjustable controls in this equipment are in several cases, associated with switches of almost the same name. Through such switches, the associated control is given two ranges of adjustment. Both cord connections and controls are explained in the following list. (To identify parts, see figure 2-1.)

a. "POWER" connector (1).

b. "POWER" switch (2).

c. "SYNC IN" connector (3). This is the input point for external sync signals and any externally applied wave form.

d. "SYNC OUT" connector (4). The sync pulse of this generator is always available at this connector.

e. "OUTPUT" connector (5). The output pulses are available at this connector.

f. "SYNC" selector knob (6). Its "INT" position "A, B, C," permit a frequency band of the internal oscillator to be selected. position "A" covers 50 to 280 cycles, position "B" covers 280 to 1600 cycles, position "C" covers from 1600 to 10,000 cycles. The "EXT" positions are "GOING+" and "GOING−" They permit triggering of the pulse generator to occur in positive or negative-going slopes of externally-applied wave forms.

g. "PULSE RATE" dial (7) allows frequency of the internal oscillator to be varied after a frequency band is selected.

h. "BIAS" knob (8) sets the negative or positive voltage level at which the pulse generator triggers when fed a wave form through the "SYNC IN" connector.

i. "COARSE ATTN" knob (9) enables selection of voltage multipliers and internal resistances for the pulse output. Panel markings are as follows:

"COARSE ATTN"

" Multiplier	*Ohms"*	
10	2500	
1	250	
.1	50	Matched
.01	50	
.001	50	
1	75	

j. "FINE ATTN" dial (10) works in conjunction with the "COARSE ATTN" knob (9). Black engraved numerals on the "FINE ATTN" dial are multiplied by the *white* engraved multiplier value indicated by the "COARSE ATTN" knob. Red engraved numerals on the "FINE ATTN" dial combine with the *red* engraved multiplier values indicated by the "COARSE ATTN" knob. Full instructions for determining output voltages are given in paragraphs 2-7 through 2-10.

k. "SYNC" switch (11). This switch establishes whether the sync pulse will lead the output pulses or whether it will lag one or both of the output pulses. The switch has "LEAD" and "LAG" positions.

l. "DELAY" switch (12) is associated with the "DELAY" dial (13). The switch has "SHORT" and "LONG" positions.

m. "DELAY" dial (13) is the continuous control for varying the time between T-o and T-d (see figure 1-3). The dial has the "SHORT" scale of 2-20 usec and the "LONG" scale of 20 to 220 usec. These scales are selected by the "DELAY" switch. Red markings are the "LONG" scale.

n. "PULSE NO. 2" switch (14) switches on, or eliminates the pulse that occurs late in time. Positions of the switch are "IN" and "OUT".

o. "SEPARATION" dial (15) permits adjusting the time between the output pulses from 2 to 30 usec. "PULSE NO. 2" switch must be in "IN" position.

p. "WIDTH" switch (16) is associated with the "WIDTH" dial (17). The switch has "NAR" (narrow) and "WIDE" positions.

q. "WIDTH" dial (17) is the continuous control for setting the width of output pulses. The dial has the narrow scale of 0.5 to 10 usec, and wide scale of 10 to 100 usec. These scales are selected by the "WIDTH" switch. Red markings are the "WIDE" scale.

r. "POLARITY" switch (18) has "NEG" (negative) and "POS" (positive) positions. This switch determines the polarity of the output pulses.

s. "RISE TIME" dial (19) provides adjustment of the rise time of the output pulses. The dial is calibrated from 0.05 to 0.25 usec.

t. "GND" connector (20) is an extra ground point, often helpful when hooking up several instruments.

2-3. SEQUENCE OF OPERATION.

2-4. ENERGIZING EQUIPMENT. With cord CX-337/U (5, figure 1-1) connect the power connector (1, figure 2-1) to a source of 115 volts, 50 to 1000 cps, single phase. Turn "POWER" switch (2) to "ON" position.

Note

Allow 15 minutes warm-up time after turning power "ON" to assure uniform performance.

2-5. CONNECTING CORDS. Connect cords CG-409A/U (3, figure 1-1) to "SYNC OUT" connector (4, figure 2-1) and to "OUTPUT" connector (5). This cording arrangement permits operation in the "INT SYNC" position of the "SYNC" selector knob (6). When an external oscillator or waveform is to be used, it is connected with another cord CG-409A/U at the "SYNC IN" connector (3). Then "EXT SYNC" positions, "GOING+" and "GOING−" of the "SYNC" selector knob take effect, and the "BIAS" knob (8) also becomes effective. Whenever there is need for a cord with clip ends, use cord CG-521A/U (4, figure 1-1). The pulse generator is now prepared to provide pulses and wave forms for the testing of other equipment.

Note

To secure the best rise time when output pulses of 2 to 200 volt amplitude are wanted, use the shortest possible connecting leads of unshielded wire from the "OUTPUT" connector. The best rise time is obtained when the r-f cable is not used.

2-6. ESTABLISHING THE PULSE PATTERN. (See figure 2-1.) To establish the pulse pattern, use the following controls:

a. Assuming that internal sync is to be used, set "SYNC" selector knob (6) to the desired pulse rate band.

b. Tune "PULSE RATE" dial (7) to the proper frequency.

c. Set the "SYNC" switch (11) in "LEAD" position if the sync pulse is to lead the output pulses. Set the switch to "LAG" position if the sync pulse is to lag one or both of the output pulses.

d. Set the "DELAY" switch (12) to "SHORT" position if required delay time falls within 2 to 20 usec. Set switch to "LONG" position if required delay time falls within 20 to 225 usec.

e. Set the "PULSE NO. 2" switch (14) to "IN" position if two output pulses are wanted. Use "OUT" position if only one output pulse is wanted.

f. If a second pulse is used, adjust the separation time with "SEPARATION" dial (15).

g. Turn "DELAY" dial (13) to secure exact delay time required.

h. Set the "WIDTH" switch (16) to "NAR" position if required width falls within 0.5 to 10 usec. Set switch to "WIDE" position if required pulse width falls within 10 to 100 usec.

i. Turn "WIDTH" dial (17) to secure the exact pulse width required.

j. Set "POLARITY" switch (18) to either "NEG" or "POS" position to secure either negative or positive pulses.

k. Adjust "RISE TIME" dial (19) as required.

2-7. ESTABLISHING OUTPUT PULSE VOLTAGE. The voltage of output pulses is determined directly when the 2500 and 250 ohm outputs are unloaded. The white engraved multiplier shown by the "COARSE ATTN" knob (9, figure 2-1) is multiplied by the black number shown by the "FINE ATTN" dial (10). But voltage becomes different from the indicated value when the output is loaded. The following formula shows how to calculate actual output voltages in the 2500 and 250 ohm positions.

$$\text{V out} = \text{V dial} \times \text{Multiplier} \times \frac{1}{1 + \frac{Rg}{Rl}}$$

Where: V out is the actual voltage.

Where: V dial is value set on "FINE ATTN" dial.

Where: Multiplier is numeral selected by "COARSE ATTN" knob.

Where: Rg is "OHMS" resistance selected by "COARSE ATTN" knob.

Where: Rl is ohms resistance of connected load.

2-8. In the following example by substituting the indicated values, the 50 volts indicated by the control positions reveals itself to be an *actual* 33 volts. For this reason, calculate voltages when exact pulse amplitudes are needed.

$$\text{V out} = 5 \times 10 \times \frac{1}{1 + \frac{2500}{5000}}$$

$$= 50 \times 2/3$$

$$\text{V out} = 33 \text{ volts}$$

2-9. For the "MATCHED" positions of the "COARSE ATTN" knob (9, figure 2-1) a slightly different formula is necessary. All the identifications of factors are the same as in paragraph 2-7. The formula is:

$$\text{V out} = \text{V dial} \times \text{Multiplier} \times \frac{2}{1 + \frac{Rg}{Rl}}$$

2-10. In the "MATCHED" positions, calculation is not necessary when the connected load offers the same resistance as indicated on the pulse generator panel, namely 50 or 75 ohms.

2-11. ESTABLISHING TRIGGERING POINT ON EXTERNAL WAVEFORM. When the pulse generator is fed by an external oscillator through the "SYNC IN" connector, the "EXT SYNC" and the "BIAS" controls are useable. The pulse generator may be triggered at any point on the external waveform by adjusting the "BIAS" and the "EXT SYNC" controls. (See figure 1-4).

SPECIAL NOTICE

To stop equipment in an emergency, turn "POWER" switch (2, figure 2-1) to "OFF" position. Pull the cord CX-337/U (5, figure 1-1) out of the "POWER" connector (1, figure 2-1).

2-12. PRECAUTIONS TO BE OBSERVED.

2-13. PULSE RATE AND PULSE PATTERN OVERLAP. No damage will occur, but no usable output can be secured if the pulse pattern is too wide for the pulse rate. Maximum pulse pattern width at 10,000 cps is approximately 80 usec. Maximum pulse rate available at the maximum pulse width of 255 usec, is approximately 3400 cps. A jumbled presentation on the oscilloscope indicates an overlapping condition. In such a condition dial readings are meaningless.

2-14. PULSE WIDTH AND SEPARATION OVERLAP. When two output pulses are used, their width must be kept smaller than the separation or there will be overlap and only one pulse of irregular and nonusable characteristics will result. Keep "PULSE WIDTH" values smaller than "SEPARATION" values when two output pulses are used.

SECTION III

OPERATING CHECKS AND ADJUSTMENTS

3-1. GENERAL CHECKS.

3-2. POWER CHECK. When the pilot light is lit, it means that power is reaching the pulse generator.

3-3. Operating hook-ups of this pulse generator practically always include an oscilloscope to permit results to be observed. With an oscilloscope in the test hookup it is a simple matter to vary controls of the pulse generator and note whether there is an equivalent change in the indicator presentation. Failure to respond means further check should be made.

3-4. CHECKING WITH AN OSCILLOSCOPE.

3-5. A direct check of operation may be made by connecting the "OUTPUT" connector and the "SYNC OUT" connector to signal input and the external sync connectors of an oscilloscope. Turn power on in both units and give them 15 minutes to warm up and stabilize.

3-6. Set controls of the pulse generator in the following manner: — (See figure 2-1).

a. "SYNC" selector knob (6) — "C" position.
b. "PULSE RATE" dial (7) — 4.0 kc.
c. "SYNC" switch (11) — "LEAD" position.
d. "DELAY" knob (13) — 40 usec.
e. "DELAY" switch (12) — "LONG" position.
f. "SEPARATION" knob (15) — 20 usec.
g. "PULSE NO. 2" switch (14) — "IN" position.
h. "WIDTH" knob (17) — 10 usec.
i. "WIDTH" switch (16) — "NAR" position.
j. "RISE TIME" knob (19) — 0.05 usec.
k. "POLARITY" switch (18) — "POS" position.
l. "FINE ATTN" knob (10) — 20 (black numerals)
m. "COARSE ATTN" knob (9) — "1. - 250 ohms"

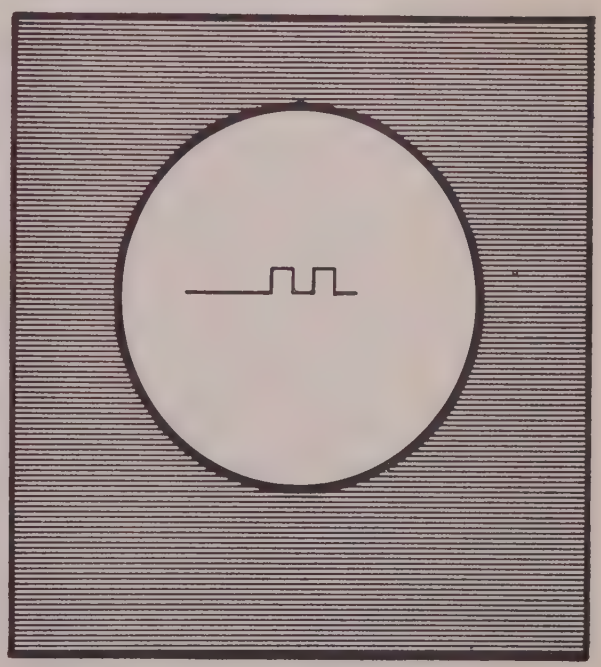


Figure 3-1. Test Pulse Pattern

3-7. In the oscilloscope, set the controls for 200 usec sweep time, positive polarity and external sync. If the external sync control has several positions, use a position which includes the 50 volt range. Adjust the oscilloscope controls as necessary to reveal the complete pulse pattern. It should be as indicated in Figure 3-1. It will be seen that the 20 volt amplitude 40 usec delay 10 usec width and 20 usec separation are occurring properly in accordance with control settings.

SECTION IV
EMERGENCY OPERATION AND REPAIR

4-1. EMERGENCY OPERATION.

4-2. If the pulse generator does not oscillate with the "SYNC" selector knob in "INT" position, it is possible to secure pulse repetition from an external source. Switch "SYNC" selector knob (6, figure 2-1) to the desired "EXT" position. Connect an external oscillator to the "SYNC IN" connector (3).

4-3. Output pulse voltages may be below the bias level of the equipment under test. Raise the "COARSE ATTN" and "FINE ATTN" knobs (9 and 10, figure 2-1) to their highest readings if equipment does not react at a low amplitude.

4-4. EMERGENCY REPAIR.

4-5. If the pulse generator stops operating, check the power cord. Then replace the fuses on the front panel with the spare fuses which are also located on the front panel and are marked "SPARES". The pilot light may also be replaced by unscrewing the lens.

4-6. REPLACEMENT OF ELECTRON TUBES.

4-7. Any of the electron tubes in this pulse generator may be replaced by the operator. The electron tubes are all located on the top of the chassis. Their reference symbol numbers and JAN type numbers are stamped on the chassis in black ink close to the tube sockets. The electron tubes are exposed by loosening the captive screws at the edges of the front panel and then pulling the chassis out of the dust cover.

CAUTION

Disconnect power while removing the equipment from the case.

Table 4-1. Electron Tube Complement

Qty	Reference Symbol Number	JAN Type Number	Qty	Reference Symbol Number	JAN Type Number
4	V1	JAN 6AU6		V15	JAN 5814
5	V2	JAN 5814	2	V16	JAN 6AH6
	V3	JAN 6AU6		V17	JAN 6AH6
	V4	JAN 6AU6	1	V18	JAN 6AN5
1	V5	JAN 6D4	1	V19	JAN 829B
	V6	JAN 5814	1	V20	JAN 6005
4	V7	JAN 12AT7	1	V21	JAN 5R4WGY
2	V8	JAN 5725	2	V22	JAN 6AS7G
	V9	JAN 12AT7		V23	JAN 6AS7G
	V10	JAN 5725		V24	JAN 6AU6
	V11	JAN 12AT7	1	V25	JAN OA2
	V12	JAN 12AT7	1	V26	JAN 6X4W
	V13	JAN 5814	1	V27	JAN OB2
	V14	JAN 5814			

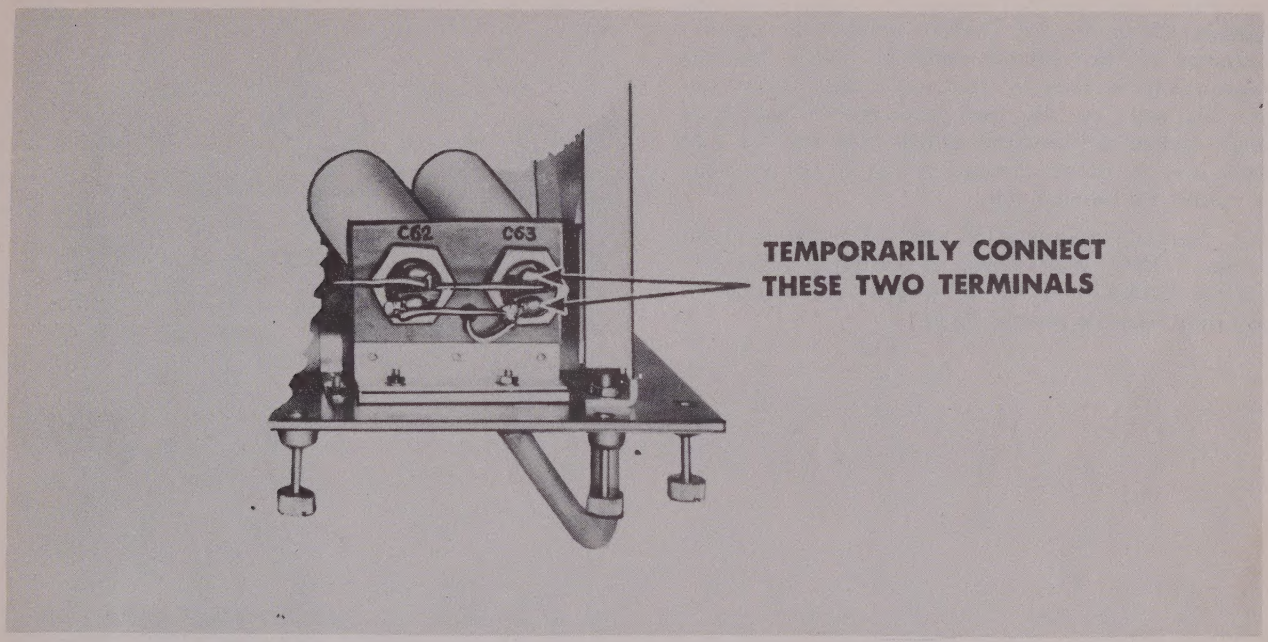


Figure 4-1. Bypassing Output Capacitors

4-8 When an electron tube does not glow, and does not feel warm to the touch while power is on, it is likely that the tube has failed. Remove the tube and insert another of the same type.

4-9. Table 4-1 is a list of the reference symbol numbers and the types of the electron tubes.

4-10. BYPASSING OUTPUT CAPACITORS.

4-11. Capacitors C62 and C63 on the back of the front panel eliminate d-c voltage from the output pulses, which is desirable in certain situations. These capacitors cause a maximum of 10 percent drop-off from square wave pulse shape in the "MATCHED" positions of the "COARSE ATTN" knob. When the presence of d-c voltage is not important and the best pulse shape is wanted, bypass the output capacitors. Connect a wire across the terminals shown in figure 4-1.

4-12. "WIDTH" DIAL CORRECTION.

4-13. Pulse generators with serial numbers AF-1 to AF-61 inclusive, have "WIDTH" dial assemblies with the reverse side of the metal disc engraved 0 to 280 degrees. If, after repair work the front side calibration scale does not agree within ±10 percent with a reference standard, the dial is to be converted to degrees by removing the disc, turning it over and refastening it to the knob with the same screws. Then calibration cards or curves are to be made up by the users of the pulse generators to relate pulse width in micro-seconds with degrees dial rotation.

4-14. WIDTH ADJUSTMENTS.

4-15. UNITS SERIAL NUMBERED AF-1 to AF-61. Pulse generators with serial numbers AF-1 to AF-61 inclusive have two internal pulse width trimmer controls. They are located on the bracket between the "PULSE NO. 2" and the "WIDTH" switch inside the unit on the bottom edge of the front panel. One trimmer control is variable resistor R125. Turning its shaft adjusts the width of the first pulse. Variable capacitor C61 is the other trimmer control. Turning its shaft adjusts the width of the second pulse in the narrow range.

4-16. UNITS SERIAL NUMBERED AF-62 to AF-536. In units serial numbered AF-62 to AF-536, a change is made. The internal pulse width trimmer controls consist of variable resistor R124 which governs the width of the first pulse, and variable resistor R125 which is rearranged to govern the width of the second pulse. Variable capacitor C61 is eliminated.

4-17. TRIMMER CONTROLS IN PULSE GENERATOR TS-592A/UPM-15.

4-18. Pulse generators with serial numbers AF-537 thru 1358 have the nameplate designation TS-592A/UPM-15. These pulse generators contain additional trimmer controls. They allow an operator to correct the pulse characteristics if an oscilloscope shows that output does not match the characteristics required by the control dial settings.

4-19. These trimmer controls provide a range of adjustment that compensates for variations which normally occur in electron tubes, fixed resistors, and capacitors. Figure 4-2 illustrates all the trimmer controls as they exist in Pulse Generator TS-592A/UPM-15.

4-20. Use these trimmer controls only when certain that a dial's reading is in error by more than ±10

percent. Check the dial at three points after any adjustment of the trimmer controls. When readings appear to be severely in error at the high or low end of a dial scale, the dial may have been shifted on its shaft. Loosen the setscrews which hold the dial and move it in the proper direction while the control shaft is against its internal stop.

4-21. Variable resistor R130 establishes the low end of the "LONG" delay period at the required 20 usec. Put the "DELAY" switch in "LONG" position before adjusting variable resistor R130.

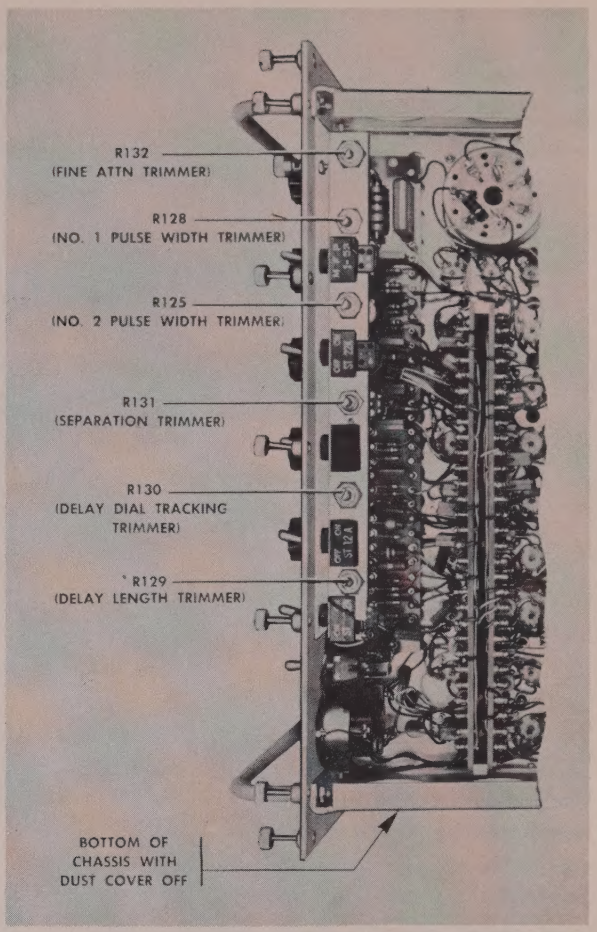


Figure 4-2. Trimmer Controls in Pulse Generator TS-592A/UPM-15